

# Exoplanet Research Program

**Astrophysics Advisory Committee**

**October 20, 2020**

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XRP Program Officer

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Megan Ansdell (Planetary Science Division)

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# Exoplanet Research Program (XRP)

The XRP is a cross-divisional program managed by all four divisions of the Science Mission Directorate at NASA Headquarters: Astrophysics (APD), Planetary Science (PSD), Earth Science (ESD) and Heliophysics (HPD).

## Timeline:

- **Feb 14, 2020:** ROSES solicitation was released
- **Mar 20, 2020:** amended in response to COVID-19 situation to allow Notice of Intent (NOI) in lieu of Step-1 proposals:
  - Streamlined submission process for proposers\*\*
  - Proposers who had submitted a Step-1 proposal by due date were not required to take additional action
- **March 27, 2020:** Step-1 proposal due date
- **May 29, 2020:** Step-2 proposals due date

\*\*Step-1 proposals require an Authorized Organizational Representative for submission whereas NOIs may be submitted by the Primary Investigator without formal institutional involvement

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This program is in its 8<sup>th</sup> year and focuses exclusively on the advancement of exoplanet science, including observational, laboratory, modeling, and theoretical studies involving:

- Detection and/or confirmation of exoplanet candidates;
- Observationally characterize exoplanets, their atmospheres, or specific host star properties that directly impact our understanding of the exoplanetary system;
- Explore the chemical and physical processes of exoplanets (including the state and evolution of their surfaces, interiors, and atmospheres);
- Improve understanding of the origins of exoplanetary systems.

The solicitation encouraged investigations that combine skills and disciplines from across divisional boundaries and advance exoplanet science through collection/analysis of new data, archival data analysis, collection/interpretation of laboratory data, and/or development of an observationally testable theory.

# Exoplanet Research Program (XRP)

## IN SCOPE

- Exoplanet investigations with a primary focus on data analysis using a NASA public domain archive (including Kepler and TESS).
- No limitations on percentages of ground-based observing, archival, theory, or modeling components of the proposal.
- Proposed investigations of stellar objects or brown dwarfs are in-scope ***if*** the main focus of the research is to advance exoplanet science.
- Observational characterization/detection of biosignatures and/or techno-signatures are in-scope.

## NOT IN SCOPE

- Studies of the formation of planetary systems focused on increasing understanding of the Solar System (should be submitted instead to Emerging Worlds)
- Theoretical or laboratory investigations focused on defining, understanding or characterizing biosignatures (Exobiology Program-relevant) or on the environmental conditions needed for life (Habitable Worlds Program-relevant)
- Investigations with major components involving collection/analysis of data from currently operating or future space missions that have Guest Investigator programs (TESS, Hubble, Webb); such proposals should be submitted directly to the GI program.
- Investigations with primary objective of maintaining/operating observing facilities or installing/developing/commissioning or assessing instrument performance.

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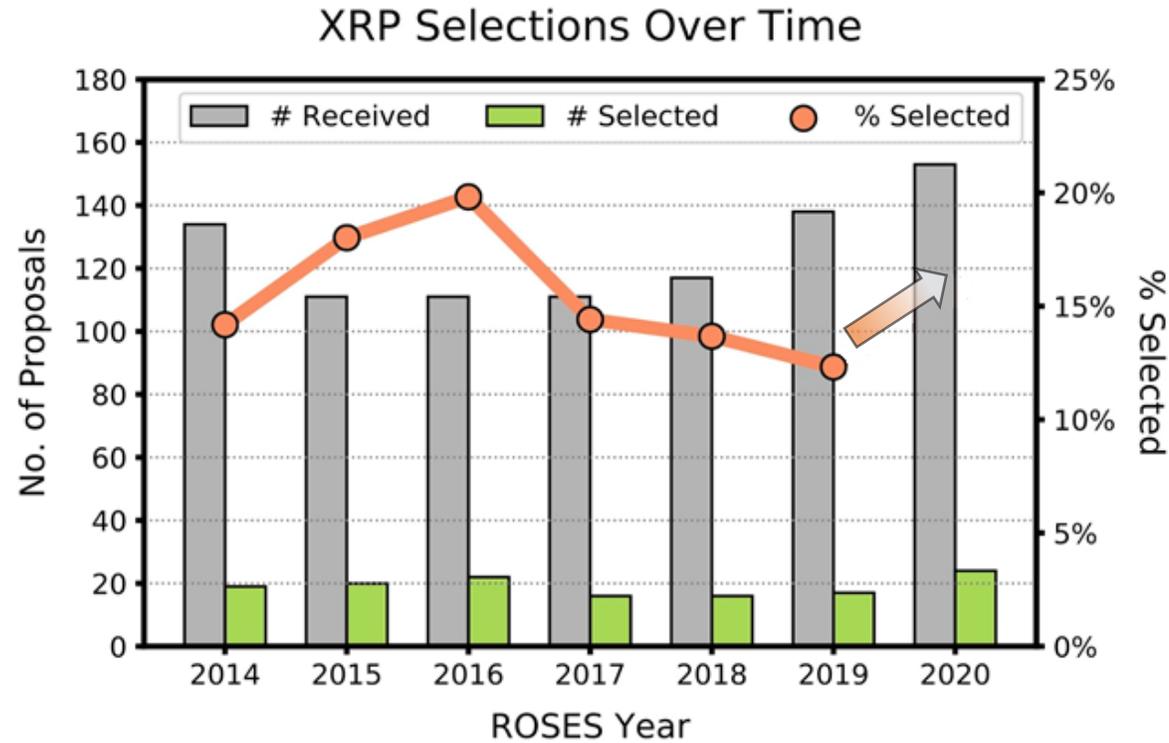
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# Exoplanet Research Program (XRP)

## Changes from past XRP solicitations:

- Starting this year, the scope of Astrophysics ROSES Appendix-D now excludes exoplanet research elements from ADAP, ATP and the Lab Astro component of APRA. The XRP is now the designated program supporting these investigations.
- A Data Management Plan (DMP) was required as part of the 15-page Scientific/Technical management section and was evaluated as part of the Intrinsic Scientific and Technology merit.

# Exoplanet Research Program (XRP)



*Number of proposals received (gray) and selected (green) for XRP. The selection rate is given in orange.*

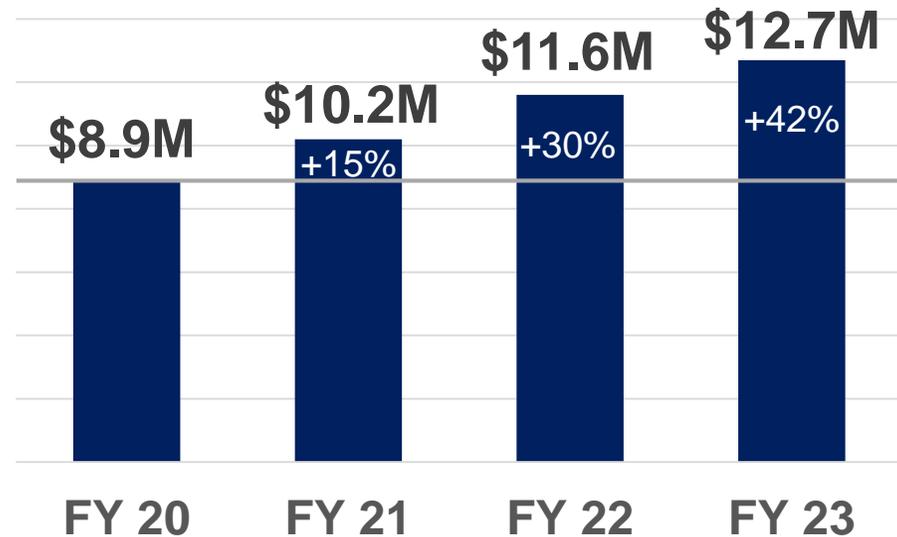
The number of submitted proposals to the XRP has been steadily rising over the past 4 years, while the selection rates have decreased. This year, with an increased XRP budget (next slide), we anticipate the selection rate to rise to ~15% in 2020.

# Exoplanet Research Program (XRP)

## Cross-Divisional Partnership

Purpose: Combine skills and disciplines from across divisional boundaries to make the most impact upon strategic and solicited exoplanet science

- Proposal review process is managed collaboratively by all four divisions
- Selections are funding-blind (i.e. not tied to specific Divisions)
- Total funding allocation for XRP has increased substantially via the cross-Divisional agreement:



*XRP budget profile FY20-23*

# Exoplanet Research Program (XRP)

## Diversity of XRP science: examples of recently-funded investigations

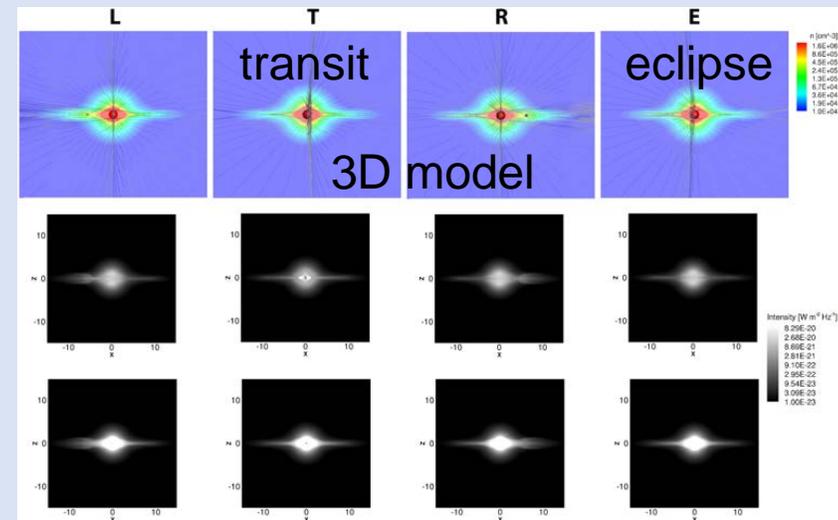
### **Modeling Exoplanet Radio Transits and their Relation to Exoplanetary Magnetic Fields**

Ofer Cohen  
(UMass)

**Objective:** Develop a method for measuring exoplanet magnetic fields.

**The Details:** Develop a time-dependent coupling between stellar corona and exoplanet magnetosphere models to investigate the relation between the planetary magnetic field strength and the magnitude/phase shift of the radio signal modulations. Apply the technique to the known planetary systems of Proxima Centauri and HD 189733.

**Key Idea:** Auroral radio signatures from exoplanets, a possible way to quantify their magnetic fields, are likely to be too weak for detection. An alternative approach is to look for modulation of the background coronal radio emission by the planetary magnetosphere (“radio transit”), from which the field strength could be derived.



simulated radio modulations (30, 250MHz)

Cohen+ 2018

# Exoplanet Research Program (XRP)

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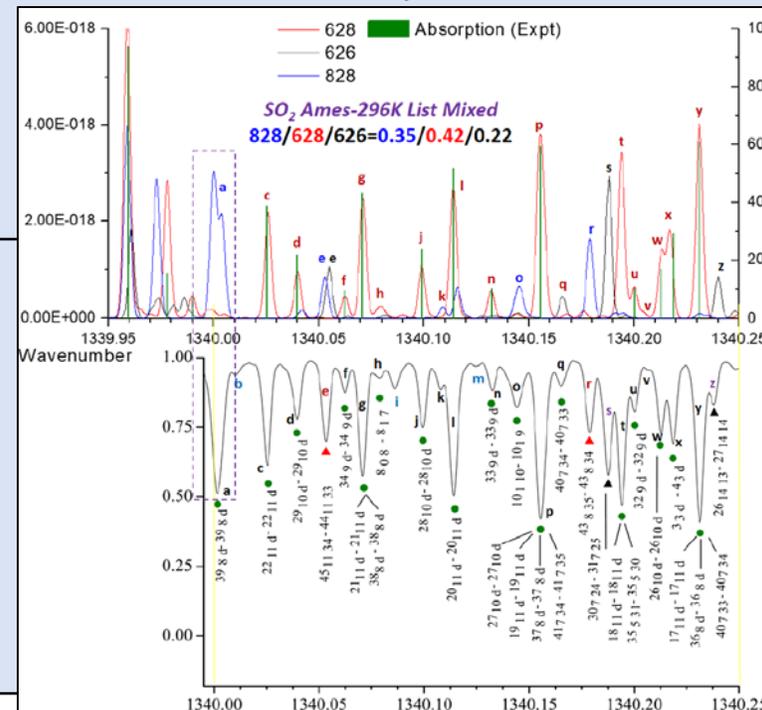
### Identifying Sulfur and Silicon Molecules in Hot Exoplanet Atmospheres

Timothy Lee  
(NASA/ARC)

**Objective:** Provide reliable, accurate and complete line lists/spectral library for small silicon and sulfur molecules (OCS, SO, CS<sub>2</sub>, SiO<sub>2</sub>) expected to be the atmospheres of hot, rocky exoplanets.

**The Details:** “Best theory + high-resolution experimental data” modeling strategy will be used to develop the spectral library, with line lists reliable up to ~2000K. In some cases, several electronic states for a given molecule will need to be examined.

**Key Idea:** While silicon and sulfur-based molecules are thought to be the most important atmospheric molecular constituents in hot, rocky exoplanet atmospheres, existing line lists for small Si and S molecules are quite limited. Such data would allow identification of these molecules in direct observations and could be used by modelers to determine opacities.



example:  
sulfur dioxide

Huang+ 2020

# Exoplanet Research Program (XRP)

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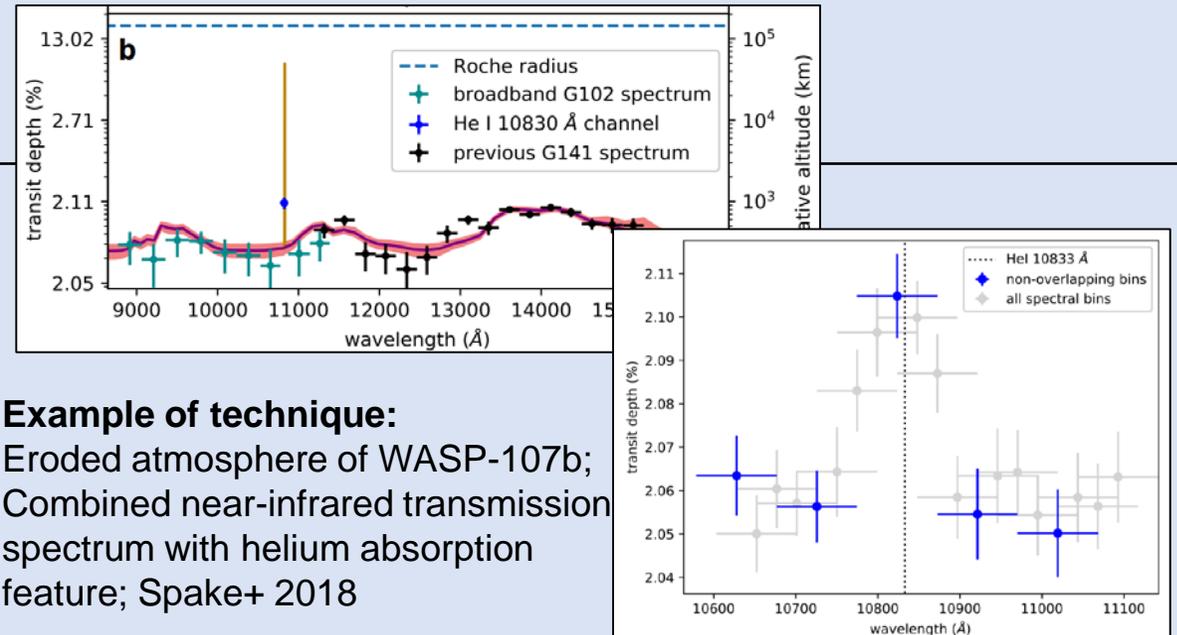
### **Observing Helium Outflows from Irradiated Exoplanets with the Hobby-Eberly Telescope**

Caroline Morley  
(UT-Austin)

**Objective:** Catch exoplanets in the act of losing their envelopes and characterize mass loss across a range of planet masses, system ages and host star activity.

**The Details:** Near-infrared high-resolution observations of the He triplet enable high-precision velocity measurements of the outflow to determine mass loss rate. Observations during non-transiting times enable characterization of stellar variability within the He triplet, providing a baseline for detection of the planet signal as well as a useful intrinsic stellar variability measure for a range of stellar hosts. Data will add to growing number of He exospheres detected via low-resolution HST observations and will support future JWST observations.

**Key Idea:** Atmospheric escape is a dominant physical mechanism sculpting short-orbit planets. Detecting and mapping outflows using Lyman-alpha are hobbled by interstellar Ly-alpha absorption, a problem avoided by using another probe, the helium triplet (1.08 microns).

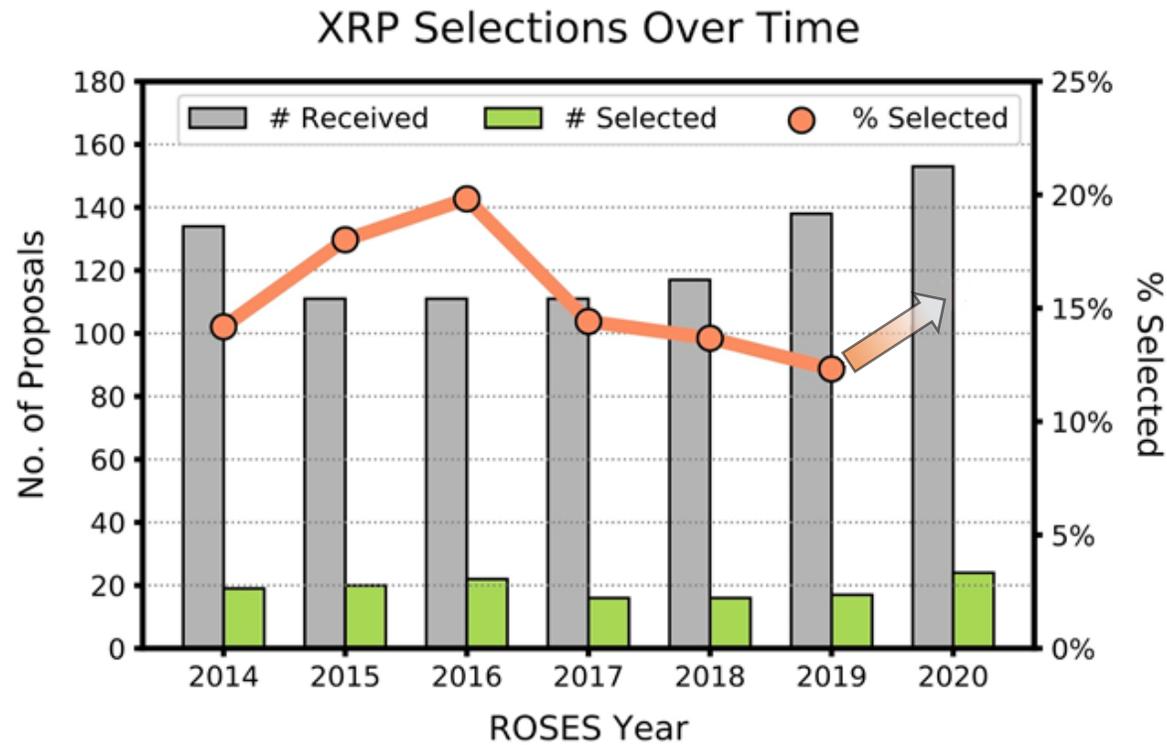


### **Example of technique:**

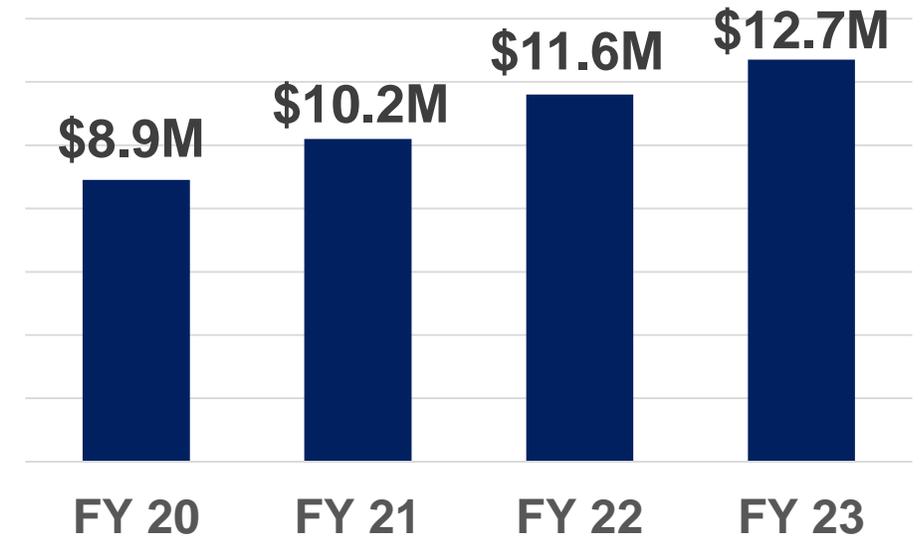
Eroded atmosphere of WASP-107b;  
Combined near-infrared transmission  
spectrum with helium absorption  
feature; Spake+ 2018

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Bottom Line: Exoplanet research is growing  
Proposals up, budget up, selection rate up



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XRP budget profile FY20-23